

## The Dynamics of the JIT/Lean System \*

*Lumbidi Kupanhy*

### *Abstract*

Any system can be judged by its goals and its results. The results are dependent on the goals and reflect the goals' ambitions. Wonderful results based on improvement activities aimed at "reasonably attainable" objectives can hardly be sustained over a long period of time. Such improvement programs are here referred to as simple or time-framed improvement programs. Continuous improvement (kaizen) implies the idea of endless efforts aimed at goals that are seemingly beyond the system's means or reach. The paper sustains thus that kaizen is a dynamic process directed toward unrealistically reachable goals. In fact, it is contended that asymptotic goals are the dynamic engine that sustains lean systems like TPS.

*Keywords:* Lean system, QCC, SS, time-framed improvement, continuous improvement, kaizen, asymptotic goals, achievable goals

### **Introduction**

This is an attempt to shed a new light on the important role of continuous improvement activities as supporting structures for successes and sustained successes. At the same time, the undertaking can be viewed as a tentative approach to clarifying the difference between one-time improvements and continuous improvements.

Furthermore, we contend that there is a strong relationship between a production system's dynamics, its pursued goals and the *types of its improvement* structures. Till now, both practical and theoretical approaches to the application (or transfer) and study of the JIT/lean production have neglected that particular, but very

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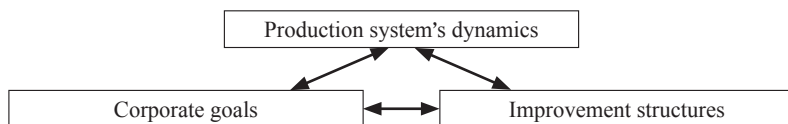
\* This paper is dedicated to Professor Akihiro Takeuchi to whom I owe so much, especially on the professional level. I am really short of words to express my profound gratitude to him for all he has done for me.

important area.

It is our belief that for a thorough understanding of the JIT/lean system, it seems necessary for both management practitioners and academics to grasp the possible type and nature of that relationship. A special effort is thus made here to tentatively try to reveal the critical importance of the missing or “not-yet explored” link.

Whereas there just remains, from the theoretical point of view, a zone of darkness concerning that unexplored link, the consequence of such lack of knowledge has more devastating effects on the field of the application of JIT/lean methods. *In fact, due to the void of that particular knowledge about the lean system, its implementation, especially in the West, was dealt with (and is still), in many cases as though it were a quick fix (similar to reengineering) to solve specific problems in a very short period of time or as a management fad of the 1980s and early 1990s.* That is why once the fixed goals were realized, after a few years or so, this efficient system ended up as a part of corporate history especially in many Western companies, instead of becoming integral part of their active life.<sup>1</sup> Yet, nobody needs magnifying lenses to see that the system continues however to produce its wonders at companies like Toyota, which keeps stunning the world by its sustained successes of its products (i.e., consistent performance) regardless of the place in the world where the system is used and its products made.<sup>2</sup>

Exhibit-1: Relationship between elements contributing to the performance of production system



<sup>1</sup> This is the results of our observations of JIT application in the West.

<sup>2</sup> See the case of SMI Koyo in France, Honda and Toyota of America.

The goals a company sets for itself are thought here to be the driving forces and one of the pillars of the neglected triangular relationship (see Exhibit-1) that determines the (kind of) performance of any production system.

The interest of this new approach consists in showing clearly the nature of corporate goals that management should set, as did the initiator of TPS. The principal function of such goals, which is also the main object of this research undertaking, is to be capable of

- creating the impetus that constrain the system to keep its internal dynamics permanently active and alive. ;
- driving continuous improvements activities that will in their turn contribute to sustained growth, sustained performance and sustained cost reduction.

*And, the system's permanent dynamics is thought to be what leads to sustained corporate successes.*

What may be the attributes of such goals? We believe that scrutinizing, analyzing and classifying JIT/lean system's goals might provide the clue to understanding its outstanding and sustained performance. This belief leads to the following crucial questions that people in management position should consider and deal with. Are the company's improvement activities successful? Can such successes be sustained over a long period of time? And most important, do the corporate goals drive improvement activities?

In order to deal with that important topic, we have organized the body of this research as follows. We start by a few words on our own research approach and interest, completed by a brief literature review of different approaches to the studies of the JIT/lean system and kaizen or improvement structures. The failure of current theoretical approaches to notice and to deal with the important aspects of the JIT/lean system's dynamics will thus be brought to the light. Next, we will sketch out two cases of our last factory study tours in Japan from which we have drawn some important lessons. At

last, these lessons are used as work hypothesis and the foundation on which the whole structure of the remainder of this paper is built.

### **Research approach, interest and methodology**

The primary source is our very long Japanese experience. In fact, we have drawn a lot on a) the personal “database” of research we conducted on the JIT manufacturing companies in Japan; b) our long Japanese academic and professional experiences; and c) numerous factory visits during the 20 years spent in Japan. The second source is a collection of data mainly from factory visits/audits conducted in the framework of INSEAD’s Industrial Excellence Award in 1999 and 2000 in France and Germany.<sup>3</sup>

Data from these two principal sources have been re-examined carefully since the idea about the importance of the relationship between the JIT/lean system’s dynamics, improvement activities and corporate goals has flashed into my mind during my last study tour of two Japanese plants. The analysis consisted mainly in

1. scrutinizing the nature of improvements made on the one hand; and on the other, the kind/nature of improvement activities in terms of their actual and expected longevity;
2. looking for link or relationship between realized improvements, company goals and the nature of deployed structure to achieve the goals and improvements;
3. identifying specific attributes of those goals.

What kind of improvement activity programs have been set up? Do corporate goals create the impetus that keeps the system’s dynamics active? How long QCC/SS have been in use? How long are they expected to continue being productive? And if SS and QCC are no longer used, no longer productive; or no longer given any priority, then

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<sup>3</sup>I are grateful to Insead Business, to CIMSO of Insead, to professors Wassenhove and Van der Heyden of Insead for having given us that opportunity. The same feeling of gratitude goes also to prof Dr Huemeier of Koblenz University for his hospitality and particular attention we were the object during factory visits/audit in Germany.

why? And so on.

Besides, we wanted also to know whether the current and past literature has adequately addressed this issue. The literature on JIT, QCC and SS structures can be considered therefore as the third source of information.

A careful screening of the most significant theoretical approaches shows that the literature on that particular aspect of the JIT/lean system is mute. Unfortunately, it neither takes into account nor deals with the dynamics of QCC/SS and of the JIT/ system as a whole.

Theoretical approaches to improvement activities feature a number of patterns that can easily be identified (Kupanhy, 2005). Descriptive and empirical studies seem to focus on the benefits of kaizen activities (Imai, 1991; Nemoto, 1983; Monden, 1983 & 1998; Kupanhy, 1994; Brunet & New, 2003). Kaizen has also been studied from the viewpoint of knowledge and cost management (Delbrige & Barton, 2002; Modarress, Ansari, Lockwood, 2005). Researchers have not only dealt with the transfer of Japanese kaizen techniques and their implementation in different managerial and cultural settings (Recht & Wilderom, 1988; Cole, 1983; Abdul-Azia, Chan, Metcalfe, 2003); but they have also examined the role kaizen can or should play (Sverker, 1992; Imai, 1991; Lillrandk, 1991, Webb 1993)

Monden's approach to kaizen seems the most interesting in the sense that it deals with kaizen within the framework of the QCC and SS structures. Kupanhy (2005) has not only shown the importance and merits of Monden's descriptive framework; but he has also gone beyond it to tentatively establish a strong relationship between QCC, SS, and successful kaizen activity programs. Yet, he has recognized the probability for a company to have improvements even though it does not feature any QCC and SS. In other words, improvements can take place outside the framework of those two structures; but he contends however that such improvements can not be sustained over a long period of time:

*“Improvement can be made without setting up QCC and SS programs. However, QCC and SS being by their nature and purpose permanent instances for improvement, without them it seems almost impossible to sustain improvements. And for me, sustained improvement is the same as continuous improvement. In fact, the analysis of the data findings has strongly suggested that companies sporting both QCC and SS are the most likely to make not only improvements but substantial improvements.”*

Although the different approaches to kaizen mentioned so far have each the merit of shedding the light on specific aspects of the Japanese concept of kaizen, they seem however to be static and have so far failed to point to the dynamics of improvement processes of the JIT/lean production system. Furthermore, they do not seem to clearly distinguish between “one-time improvements” and “continuous improvements or kaizen”.

We remember that QCC and SS are structures within which improvements can be made and sustained. On the other hand, Chandler (1962) has clearly showed through an empirical historical research that structures never come first. He has somewhat proved that the cart can not be put before the horse. Structures are set up to support specific strategies. Strategies come first. Kaizen or improvement can be viewed as strategies aimed at increasing product quality, process efficiency, workplace safety, etc. And it is well supported by QCC and SS structures.

QCC and SS play also the role of supporting structures for the lean system of which they are at the same time integral part. Therefore, their activities are aimed at the realization of the overall goals of the Toyota/JIT lean production system.

Our earlier studies of the JIT system have emphasized the fact the Japanese JIT/lean production system being made up of elements drawn from the industrial engineering field, from the Japanese management environment and from the structure of operations of the line workers (multi-process handling or multi-manning operation), an implementation of the system outside Japan based mainly on its engineering

components would definitely result in limited or partial successes (Kupanhy 1995).

We have contended that most companies that switch to JIT production experience short-lived successes not only because they focus on implementing its operational/technical aspects but also because they fail to pay attention to the supply chain system as its strategic framework of success (Kupanhy, 2005).

We have also pointed rightly to the crucial contribution of structures like QCC and SS to a real sustainable success of kaizen activities within the framework of a successful JIT system (Kupanhy, 2005). Toyota was singled out as a model example. But does it mean that setting up formal structures of QCC and SS will automatically and necessarily lead to continuous improvements and sustained successes for ever?

The void of knowledge as witnessed by the absence of any relevant literature on this matter convinced us of the necessity and importance of this research undertaking. As stated earlier, *from the theoretical point of view, there still remains a sort of a zone of darkness about this specific relationship. From the practical point of view, such lack of knowledge has led to the initiation of time-framed projects on the application of JIT/lean methods (as we could have realized during factory visits).*

### **Striking contrast of production goals: Nissan vs. Toyota**

Any system can be judged by its goals and its performance or results. The results are themselves dependent on the goals and may reflect at the same time the ambitions of those goals. Many companies take pride in the fact that their performance results are within the range of, and/or even beyond their fixed objectives. The conventional interpretation would be that management has set for the company realistic goals. But can realistic goals play the role of a dynamic engine for sustaining continuous improvements? We are inclined to answer by a “no”.

In June 2003, I visited a Nissan plant and a Toyota factory in Tochigi and Takaoka respectively, with graduate and undergraduate students from Wakayama

University, Japan. This was done in the framework of my course of Japanese Production System. So, we were among many others very interested in the kanban production system.

Interestingly, the assembly line visit at Toyota started by our being introduced to the TPS and to its kanban system. During the introductory phase to the TPS, we were reminded that Toyota aims at zero make-to-stock production. Thanks to the kanban system, it produces only the necessary items, in the required quantity, at the required time.

At Nissan, when we inquired about the kanban system, we were told that kanban was not used there any more. It was abandoned 20 years ago since it brought only problems, disturbing the production due, for instance, to drivers often confusing the number of parts with the number of kanban. We learned also that at Nissan Tochigi Plant, the make-to-order and make-to-stock production represent 60% and 40% respectively!

I then realized that the two companies should have radically different production strategies. I therefore thought the kaizen or improvement structures<sup>4</sup> set up to support their respective fundamental strategies should not be similar (should they exist at both companies' sites) at all.

Nissan, with no constraints of the kanban system and stated goals well fixed within its reach, seems assured of achieving them. But I can't help wondering what would happen after the goals are attained. In all probabilities, the improvement efforts would and can be relaxed, unless the company comes up with new targets. Besides, by not having the kanban system, the constraints of zero inventories of finished goods and its related accuracy of production forecast ceases being a priority.<sup>5</sup>

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<sup>4</sup> It is worth noting that Nissan said nothing about continuous improvement, and suggestion system. At Toyota, during the introduction to the TPS/Kanban system, our attention was intentionally drawn to a clearly visible board planted in the middle of the factory displaying the message, "Good Ideas, Good Products".



*I think that the case of Nissan clearly suggests that reachable goals set limits to improvement range, and human creativity since they confine improvements within a defined framework. On the other hand, I contend that such goals prevent the system dynamics from auto-generating its internal energy that would keep it running autonomously and continuously over an exceptionally long period of time.*

As a matter of fact, I have visited a number of companies in France<sup>6</sup> where I was given the results of improvement activities carried out just years before. Ideas have since then dried up in the cases where management had set clearly reachable objectives.<sup>7</sup> Once the goals realized, improvement activities or programs lost their *raison d'être*. Over time, they became completely inactive and ended up in the museum of past records/realizations of the company archives. In some companies, kaizen programs have been initiated, then abandoned or not given any priority any more because of the turnover of top management people<sup>8</sup> who come (and go) with different strategies.

On the other hand, it is clear that Toyota knows it will never reach its objectives although it really struggles to; that is why its deployed efforts to get at the goals will have no limits. Just for the sake of illustration of my thought, let's get a quick look at the results of its five-decade-long improvement efforts in terms of the number of suggestions for improvements.

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✓ <sup>5</sup> Forecast error can be easily absorbed by the 40% of the production-to-stock.

<sup>6</sup> I have audited factories in France in the framework of INSEAD's Industrial Excellence Award (editions 1999, and 2000). See Christoph H. Loch, et al., *Industrial Excellence*, Springer, 2003.

<sup>7</sup> The case of Caterpillar Plant in Grenoble is very instructive. Years ago, when the plant felt that it was under the threat of being closed, management set clear objectives, switched to the JIT system. At the time I visited that plant in 2000 in the framework of INSEAD's Industrial Excellence Award, the plant's life was not in danger anymore. Interestingly, QCC/SS and cost reduction methods (TPM, 5S, etc) adopted during the crisis period were clearly things of the past. We could find some vestiges of improvements made years before, but no sign of such activities going on at the time of the visit.

<sup>8</sup> It reminds me of a presentation made by two NASA engineers at the Annual Conference of Industrial Engineering in May 2005 in Atlanta. When I asked them why NASA waited so long before implementing the 5S, the answer was that they had just had a new dynamic and young manager who initiated the program.

Toyota set up the kaizen structures (QCC & SS) in 1951. On the 50<sup>th</sup> anniversary in 2001, the total cumulative number of suggestions for improvements was 34,690,000. That means an average of 693,800 suggestions per year during 50 years. In the 1980s, a period with peaks of over two millions, more than 95% of those suggestions were turned into actual improvements. In 2002, 651,000 suggestions were collected and the company did turn 99.5% of those suggestions for improvement into actual improvements.<sup>9</sup> In fact, *Toyota seems thus to prove that kaizen by its essence and nature is a dynamic process of continuous or endless improvements*. But, how can a company — be it a Toyota — sustain improvement activities and their successes over half a century? Can other companies do the same?

### **Asymptotic goals and kaizen or continuous improvements**

We contend that, wonderful results based on improvement activities aimed at realistic, i.e. reasonably attainable, objectives can hardly be sustained over a long period of time. We tentatively refer to improvement programs designed in order to attain realistic goals as *simple improvement* programs. In order to sustain such programs' activities, one will in fact have to look continuously for new targets without which continuous improvements cannot be made. Not finding new targets anymore might result in the loss of interest in improvement activities. Therefore, improvement programs designed in order to attain realistic goals can not qualify as continuous improvement or kaizen programs. *Simple improvements refer to one-time, time-limited or time-framed improvements, well confined within a specified time range during which stated goals will/should be accomplished.*

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<sup>9</sup> See Toyota Jidosha no teianseido (Toyota's Creative Suggestion System), unpublished. This document was given to me by Toyota in June 2003 during a study tour with my Japanese students of Wakayama University, in Japan. It is worth noting that while the number of suggestions have significantly shrunk, the cost saving has not. In fact, improvement's main areas have shift from production lines to engineering design rooms.

It is worth noting that improvements may be simple,<sup>10</sup> but very important. We know, for example, that reengineering is the “fundamental rethinking and redesign of the business processes to achieve dramatic improvements” (Hammer & Champy, 1994, p.32). Improvements made in the framework of reengineering — even though they are drastic or dramatic<sup>11</sup> — are time-limited. To sustain such results, processes would be under continuous redesign, which is impossible since they would become unmanageable!

With simple improvement programs, once the defined objectives are achieved, improvement activities lose their *raison d'être* and usually stop going on. The achievement of such goals ironically kills the dynamics of continuing to make further improvements, unless new, different objectives are set again. In other words, the results of such simple improvements can not be sustained over a very long period of time, less last for ever. In fact, the sustainability of such results would require continuously setting new targets without which endless or sustained improvements cannot be made (See Exhibit-2).

In the West where a high turnover of top management is a common feature, new top management people usually bring not only new blood and ideas, but also new strategies and objectives for the companies. Unfortunately this will not lead to continuous improvement programs but to *successive and/or intermittent sets of different types of improvement programs* (See Table-1). Nissan having set for itself reachable goals ended up feeling the need, in the long run, for an outsider from the West to bring in new ideas and save it from going bankrupt.<sup>12</sup>

The Toyota system constrains and challenges Toyota people to continuously come up with new ideas since its clearly stated objectives are placed at a level that can not reasonably be reached, but to which (level) the company can, through endless

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<sup>10</sup> Simple here means time-limited or time-framed as opposed to continuous.

<sup>11</sup> Hammer & Champy, 1994, pp.36-47.

efforts, get closer and closer. And Toyota relies on these ideas in order to improve its products.<sup>13</sup> The objectives of the JIT require the company either to continuously break its own records; or to sustain the effort so that it can not fall down at the lower level.

True *continuous improvements imply thus the idea of an endless effort aimed at goals that are seemingly out of the range of the means at one's disposal*. Such goals are referred here as *asymptotic* in the sense that one can get closer and closer to them, but can never achieve them 100%. In other words, the characteristics of a company's goals determine or define the nature of its improvement activities. With realistically achievable goals, improvements will definitely have limits, and end some day. *We sustain thus that the continuous improvement is a dynamic process directed toward reasonable, yet asymptotic goals* (See Exhibit-3 & Table-1). Zero inventories, zero setup, a single piece of wip are a few examples of asymptotic goals.

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✓ <sup>12</sup> When problems Nissan was experiencing started being made public in the Japanese press, I asked a young Japanese colleague of mine, why Nissan was performing badly while Toyota and Honda were doing so well in the same Japanese car market. This can not be due to the price since for similar models there is almost no difference in price between the three manufacturers. He replied that the general perception in Japan is that the defective rate for Nissan is higher. And then he added, "Look at the prices of used cars, and you will understand that Nissan cars depreciate very quickly in the mind of the car users. That is why for similar used cars, Nissan models are usually cheaper".

<sup>13</sup> In Takaoka plant, the statement "Good Thinking, Good Products" is well displayed in order to show the importance of ideas from employees. According to an un-published document I was handed, the motto was adopted in 1953!

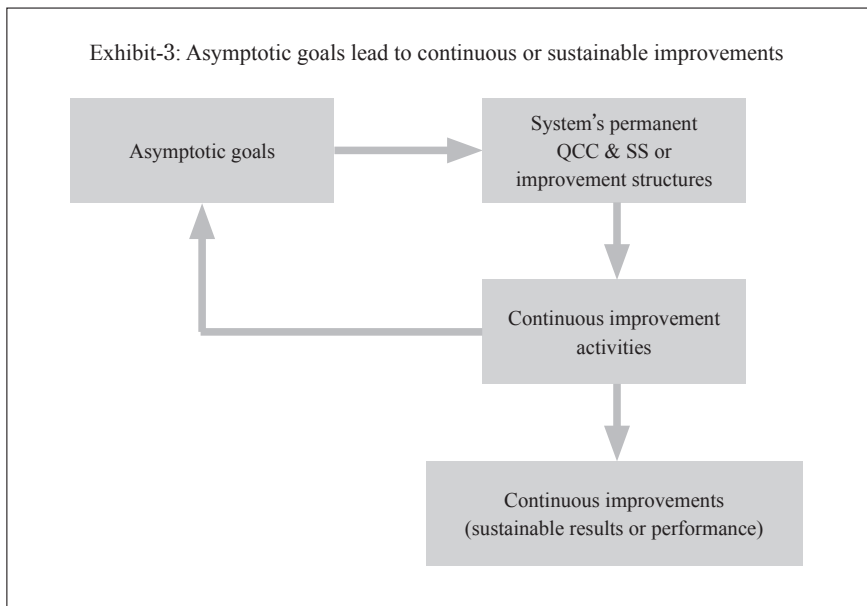
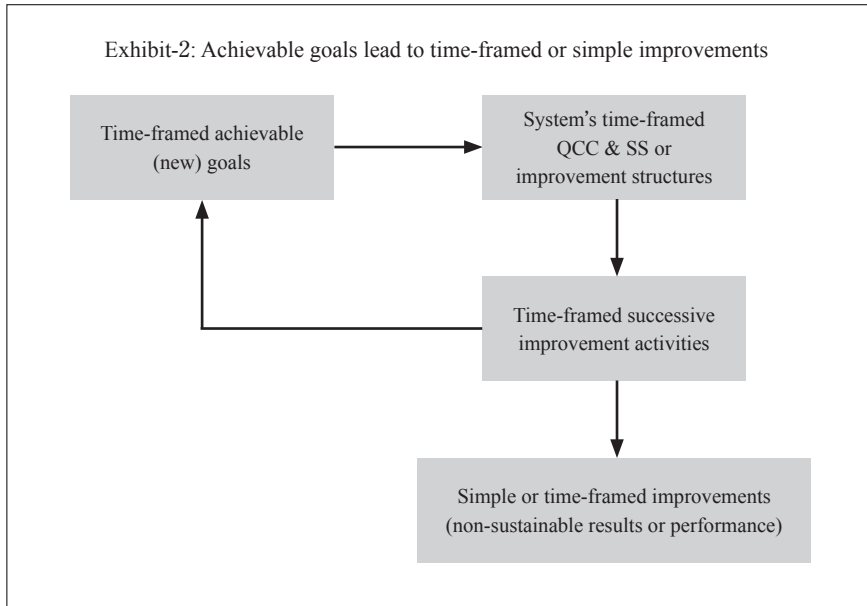


Table-1: General framework of simple and continuous improvement

System goals' ambitions	System improvement structures (QCC/SS)	Time horizon of improvement activities	Activities' results (successes)	System's dynamics or improvement initiative trigger
Reasonably achievable	Time framed	Time-framed	Time framed or simple improvements	New achievable objectives
Asymptotic	Permanent	Endless or continuous	Sustainable or continuous improvements	Same asymptotic goals

As one can clearly see, the system goals shape and define the nature of improvements activity programs a company can set up. It is therefore necessary to scrutinize the very nature of the JIT/lean production system's goals.

The objective of zero inventories, for instance, can never be attained; but it is the impetus, the dynamics behind the continuous improvement. On the other hand, If the corporate objective of cost reduction were not asymptotic (cost reduction to zero), the production department's goal would not be fixed at a reasonably un-reachable level (zero inventories), and there would be no necessity of setting asymptotic operational goals. By the same token, there would be no reason for improvement structures to be permanent. And without permanent improvement structures, it would not be possible to have continuous improvements (Kupanhy, 2005).

### Concluding lessons and perspectives

The careful examination and analysis of the very nature of improvements that any company can make led to classifying them into two groups. Kaizen are improvements that a production system sustains over a very long period of time. Ephemeral improvement are realized just "once", can last some time or during a limited period of time.

Improvements, in fact, are outputs of a system (or sub-system), the latter

being itself a structured organization with specific goals. The comparison of a system's outputs with its fixed goals can be referred to as the system's performance. In other words, the notion of performance for a system would lose completely its intrinsic meaning unless there is a clear and explicit reference to the system's goals. If any system can be judged by its goals and its results, the paper has tried to show that "the results themselves are not only function of the goals but they reflect, at the same time and above all, the goals' ambitions." Improvements (even though they are wonderful, drastic or dramatic) resulting from activities or structures such as QCC and/or SS but aimed at "reasonably achievable" objectives can hardly be sustained over an exceptionally long period of time (Exhibit-2). Such improvements (and their structures) have been referred to as simple or time-framed improvements. Continuous improvements or kaizen imply the idea of endless efforts aimed at goals that are seemingly beyond the system's means or reach. The paper sustains thus that kaizen is a dynamic process driven by and directed toward unrealistically reachable goals. In fact, it has brought to the light the fact that only asymptotic goals make up the dynamic engine that sustains lean systems like TPS (Exhibit-3).

The sustained successes of lean companies are due to their extremely demanding asymptotic goals that make up the dynamics its JIT/lean production system. And it is that dynamics that keeps the JIT/system alive forever.

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